Spatial and Temporal Variability in Vapor Intrusion Investigations

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I. Abstract

Properly investigating a contaminated site requires obtaining enough data of sufficient quality to achieve a good understanding of all routes of potential exposure. Past assumptions that soil and groundwater are the only media needing investigation have been found to be invalid. Vapors emanating from subsurface contamination can be a considerable risk to human health and therefore, consideration of the potential for vapor intrusion into buildings is an essential part of site investigations. Soil gas sampling directly measures contaminants in the vapor phase fluxing from source to the surface and is one of the preferred means to assess the vapor risk. To adequately assess the potential of a vapor risk, soil gas samples must be taken at locations that will reflect the true risk to current or potential future occupants.

Since soil is usually heterogeneous in distribution, multiple soil gas samples are typically required to make decisions on risk. The more samples collected, the more certainty in the decisions made. Budget constraints require that the number of samples be minimized. Thus an uncomfortable polarity exists between costs and need for certainty. Therefore, taking vapor samples from the best locations possible is essential.

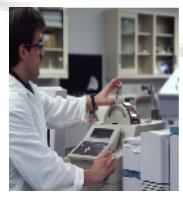
Performing a soil gas screening survey using a passive sampler is a cost effective means to obtain an accurate picture of subsurface conditions, including locating areas of elevated soil gas contaminant. Using the screening survey results to focus more complicated soil gas sampling procedures allows for the proper placement of sampling locations and therefore, an increase in accuracy of the risk assessment.

The following demonstrates how spatial and, to a degree, temporal variations can impact the effectiveness of a vapor intrusion investigation and will show how a passive soil gas screening survey can increase the accuracy of sample placement.

II. Passive Vapor Sampler

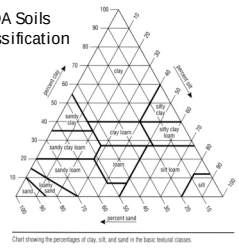
- Patented, passive, sorbent-based sampler–GORE™ Module
- Hydrophobic sorbents
- GORE-TEX® membrane waterproof & vapor permeable
- US EPA ETV Validated
- Simple installation and Retrieval
- Soil gas, sub-slab, air

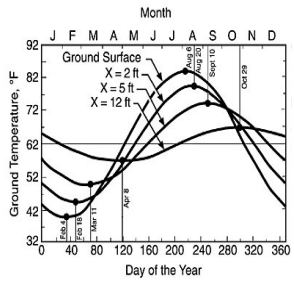
- EPA methods 8260/8270/TO-17 (TD/GC/MS)
- Duplicate samples inherent in Module



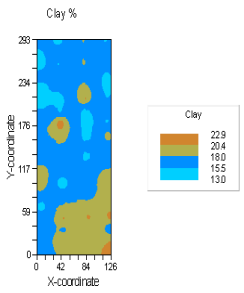
III. Soil Variability

USDA Soils Classification





www.learner.org/.../tulips/SoilTempDigDeep.html



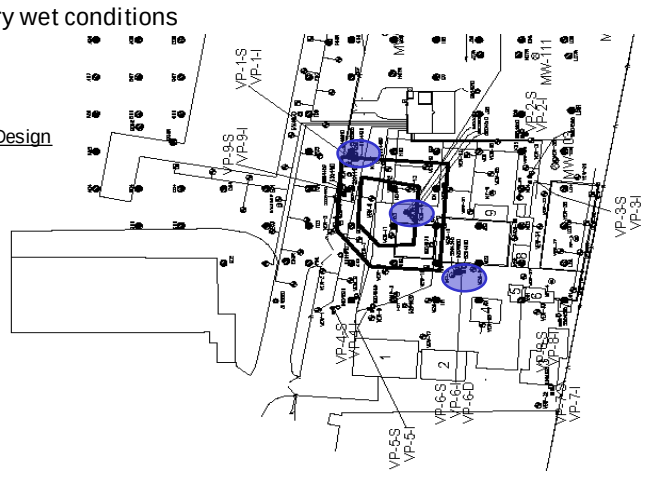
Spatial Variability of Physical Properties in Lihen Sandy Loam Soil, Poster 5/18/06, Jabro, Stevens, Evans, USDA http://www.sidney.ars.usda.gov/Site_Publisher_Site/pdfs/research_pdfs/Jabro_ASA_05.pdf

- Properties of soils can vary spatially and seasonally.
- Soil heterogeneity, temperature, moisture, building and wind effects, all influence the amount of contaminant in the soil vapor.

IV. Site Investigation – Mid-West

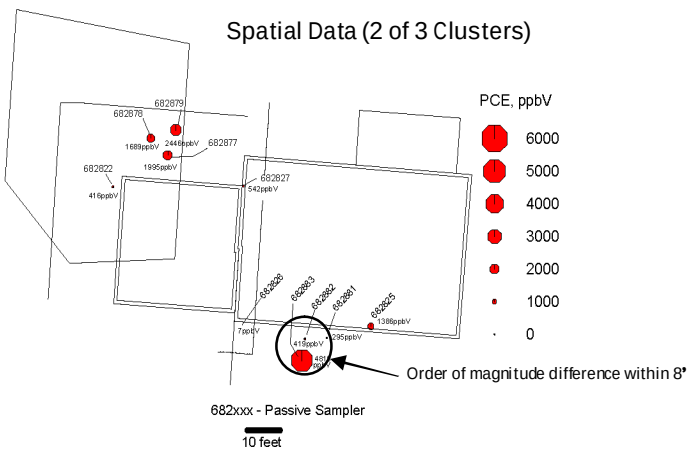
- Former Chemical Plant
- Contaminated soil and groundwater, chlorinated solvents and petroleum fuels
- Passive samplers deployed in semi-grid pattern (~30 ft spacing), winter 2006 & spring 2008
- Triangular clusters (3 modules ~8 ft spacing) to help understand extent of spatial variability
- Winter 2006 – Snow on frozen ground
- Spring 2008 – Very wet conditions

Survey Design



Cluster location

V. Variability within Cluster



- Observed order of magnitude of variability within 8'.
- Single location soil gas sampling can lead to incorrect screening decisions.

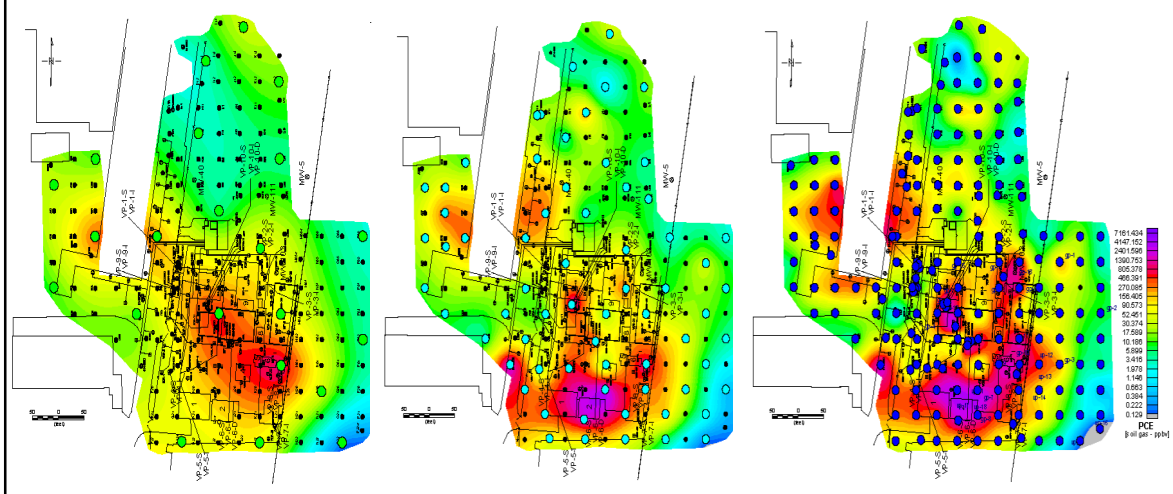
VI. Impact of Sample Spacing

Spring 2008 Results (Illustration of effect of increasing the number of sample points)

100 to 170' Spacing
~20 Sample Locations

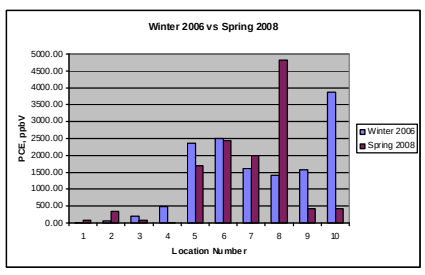
50 to 100' Spacing
~45 Sample Locations

25 to 70' Spacing
~65 Sample Locations (Actual)



- Decreasing the spacing increases the resolution of the survey, allowing better placement of more intrusive sampling techniques.

VII. Effect of Temporal Variability (Winter 2006 vs. Spring 2008)

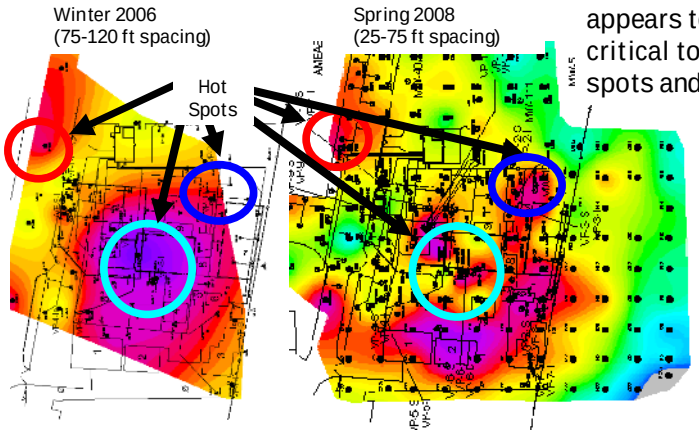


Location	Winter 06	PCE, ppbV	Spring 08	PCE, ppbV
1	514691	20.32	682872	79.39
2	514692	68.28	682871	348.00
3	520443	207.36	682868	71.21
4	520448	491.80	682875	23.84
5	520449	2367.88	682878	1689.21
6	520450	2497.98	682879	2446.21
7	520451	1618.17	682877	1994.88
8	520454	1415.77	682883	4819.47
9	520455	1578.57	682882	419.08
10	520456	3880.42	682881	419.08

- Comparisons vary by location
- Number of samples appears to be more critical to define hot spots and extents.

Winter 2006
(75-120 ft spacing)

Spring 2008
(25-75 ft spacing)



VIII. Conclusions

- Spatial and temporal variability of soil conditions have a significant impact on soil gas values.
- Isolated or too few soil gas samples will under sample the site and lead to incorrect screening and risk assessment decisions.
- Temporal/ seasonal effects can effect individual soil gas values. However, a properly designed soil gas survey using a sufficient number of samples can define areas of potential VI concern and appears to be season independent.
- More intrusive sampling techniques including MIPs, monitoring wells, soil borings and active soil gas samples can be located with a higher degree of confidence following a passive soil gas survey.
- Passive soil gas sampling can provide an economical means of obtaining the information needed to help accurately characterize a site.

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